



DEPARTMENT OF TRANSPORTATION
HAZARDOUS MATERIALS REGULATIONS BOARD
WASHINGTON, D.C. 20590

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[49 CFR Part 173]

[Docket No. HM-102; Notice 72-7]

TRANSPORTATION OF HAZARDOUS
MATERIALS

Flammable, Combustible, and
Pyroforic Liquids; Definitions

The Hazardous Materials Regulations Board is considering an amendment to § 173.115 of the Department's Hazardous Materials Regulations to specify a new definition for the class of materials identified as "Flammable Liquid" and to create and define a new class of materials identified as "Combustible Liquid." Also, it is proposing to modify the definition for pyroforic liquids within the "Flammable Liquid" class.

On February 27, 1968, the Board published a notice of proposed rule making, Docket No. HM-3 (33 F.R. 3382) proposing a new definition for "Flammable Liquid." On February 21, 1970, the Board published a notice of proposed rule making, Docket No. HM-42; Notice No. 70-3 (33 F.R. 3298) proposing to create and define a new class of materials identified as "Combustible Liquid." On December 5, 1970, the Board published a notice of proposed rule making, Docket No. HM-67; Notice No. 70-23 (35 F.R. 18534) proposing to change the method for determining the flashpoint of materials from the Tagliabue open-cup test method to the Tagliabue closed-cup test method. None of the above-mentioned rule-making proposals have resulted in an amendment to the Hazardous Materials Regulations. The matters proposed in those dockets, hereafter referred to as 3, 42, and 67, are hereby consolidated within this docket and the reasons and justifications, except as modified herein, given in their preambles are made a part of this rule-making proposal.

The proposals made in 3, 42, and 67 raised considerable controversy. Comments were addressed to the need for change, the degree of change, the method specified for testing, and the lack of uniformity in defining flammable and combustible materials.

Combustible liquids. Much interest was expressed in the proposal to regulate "combustible liquids." The Board notes that while virtually all commenters acknowledged the problem the rule making was designed to solve, there was considerable divergence of views on the proposed solution. In 42, the Board described the problem as follows:

Combustible liquids are routinely transported in tank cars, tank trucks, and portable tanks with no requirement that these tanks be identified during transportation as containing a material having a fire hazard.

Fire, police, and rescue personnel are generally trained to deal with fuel oil and kerosene accidents in the same manner as they deal with gasoline accidents. In order to be able to do their job, they must have immediate information regarding the contents of these tanks. Without this information, the emergency personnel might well be misled into believing that the tanks contained some innocuous commodity such as milk or molasses. Their attention might, therefore, be misdirected away from this significant potential hazard * * *.

Compounding the problem of lack of information as to hazards is the fact that many tank truck operators are transporting combustible liquids in tanks which bear the placard "Non-Flammable." This is apparently done in order to be able to permanently mark the word "Flammable" on tanks which are used interchangeably in shipping flammable or combustible liquids. In that way, the carrier need only to add a small tag or plate with the word "Non" on it rather than having to constantly remove and replace a larger placard having the word "Flammable." Placarding of this type is a gross misrepresentation of the actual hazard that would be present should such vehicles be involved in accidents, parked or stopped near fires, or otherwise placed in jeopardy.

No one questioned the basis for the Board's concern. In fact, several commenters, including State governments, agreed that a problem existed that required solution for the public's protection. Rather than question the need for the new classification, most commenters addressed themselves to the details of scope and implementation.

One commenter noted that 18 U.S.C. 834 directs the Department "to formulate regulations for the safe transportation within the United States of explosives and other dangerous articles, including radioactive materials, etiologic agents, flammable liquids, flammable solids, oxidizing materials, corrosive liquids, compressed gases, and poisonous substances." He contended that the word "including" tended to limit the Department's jurisdiction to regulation of the listed items, thereby excluding "combustibles." As a common practice in legal drafting, utilized throughout the United States Code, the term "including" serves to introduce examples of a broad class of items in order to provide a partial definition of that class. The Board believes this to have been the intent of Congress in enacting the Explosives and Combustibles Act of 1908, and is of the opinion that the contention of lack of jurisdiction is without merit.

A very large percentage of the commenters on 42 addressed themselves to what temperature level, 150° F. or 200° F., is the more justified upper limit. The same sources were cited in certain instances to support either the 150° or the 200° break point. This depended on the

approach they considered in citing the reference.

No convincing argument was presented to support the 150° F. cutoff. The Board believes that it must not ignore the significant number of materials having flashpoints between 150° and 200° F. being transported. To do so would not accomplish the stated objective of its proposal. The Board is aware of the fact that these materials have flashpoints higher than credible ambient temperatures, and that they are less likely to ignite than the lower flashpoint materials. Their vapors, however, can ignite when exposed to elevated temperatures caused by other than normal ambient conditions. Several commenters suggested the Board had no adequate accident data in the area of higher flashpoint materials. It is true that such data is limited due to the fact that these materials have never been covered by a hazardous materials incident reporting procedure. There are, however, accident reports on file with the Bureau of Motor Carrier Safety, Federal Highway Administration, that relate the facts of accidents involving fires fueled by "combustible liquid" cargoes. For those who question the potential of these materials to cause or contribute to harm, the Board urges reading of the National Transportation Safety Board report, dated March 7, 1968, on the railroad-highway grade crossing accident in Everett, Mass., on December 29, 1966. The tank motor vehicle involved in that particular accident was transporting fuel oil. Thirteen people were killed " * * * due to thermal burns and smoke inhalation * * * "

One concern expressed by several commenters was the need for establishing a new classification. This is necessary because of the structure of the Hazardous Materials Regulations. Before a material is regulated as a hazardous material, it must be classed as a hazardous material. Although the Board has several rule making actions and studies in progress concerning test and definition criteria for the classification of materials, it does not contemplate any change from a classification type of system. It is necessary, therefore, to establish a "Combustible Liquid" classification.

Method of test for flashpoint. In its proposal to convert from the open-cup to the closed-cup test method in 67, the Board said:

The flash point is generally accepted as a useful means to determine the flammability of flammable liquids, and therefore their potential fire hazard during transportation. The Tagliabue open-cup testing method, which has been in use with only minor modification for many years, lacks the precision, reliability, and reproducibility necessary to properly estimate the flammability hazard that may be encountered during transportation * * * .

As part of the Department's overall review of the Hazardous Materials Regulations, the Board and the staff of the Office of Hazardous Materials (OHM) have been evaluating methods used for classification of materials according to the hazard presented during transportation. OHM contracted with the Safety Research Center, U.S. Bureau of Mines, to examine the limitations

of the available flash point testers and to recommend the best method for adoption by DOT.

In reaching their conclusions, the Bureau of Mines measured the present state of the art against the following criteria:

1. Repeatability (data obtained by the same analyst in several determinations, using the same equipment and the same sample).
2. Reproducibility (data obtained by several analysts, each using a different piece of equipment of the same type, and using the same sample).
3. Reliability in assessing the fire or explosion hazard.

In addition, the Bureau of Mines considered and evaluated all comments received in response to that part of a prior notice of proposed rule making (NPRM)¹ dealing with definitions of flammable liquid, flashpoint, open-cup tester, and closed-cup tester. The results and recommendations of the Bureau's study have been reported.²

The Bureau's report recommends that the Tag closed-cup method be used to determine flashpoints of flammable liquids for purposes of the DOT Hazardous Materials Regulations. The conclusions, proposing adoption of the closed-cup method, may be summarized as follows:

1. The closed-cup method is more precise and reliable than the open-cup method, gives more reproducible data, and provides a more conservative estimate of the hazard presented by the formation of flammable vapor-air mixtures under either confined or unconfined conditions.
2. It is often proposed that an open-cup more nearly approximates the geometry of a spill situation than does a closed-cup. In our judgment, this is a trivial consideration in choosing among the variations of existing apparatus. The actual likelihood of ignition of a spill depends heavily upon factors which are beyond the scale of laboratory apparatus, such as the cooling of the liquid surface by evaporation or the gustiness of the atmosphere.³

The greatest explosion hazard results from leakage or spillage into surroundings that provide some confinement, such as a railroad boxcar, a van-type truck, or the hold of a ship. In this situation, convection currents aid the formation of homogeneous vapor-air mixtures and the magnitude of overpressures in confined combustion is usually greatest with homogeneous mixtures. Here again, the closed-cup gives the best definition of hazard.⁴ Experience shows that spills and leaks in confinement are common accident situations and must be considered in the development of safety criteria.

3. Due to its greater reliability, the closed-cup method has been accepted by the National Fire Protection Association, the National Academy of Sciences, the United Nations Intergovernmental Maritime Consultative Organization (IMCO), and many western European industrial countries, including Great Britain, France, West Germany, Sweden, and the Netherlands.

Additional reasons supporting the closed-cup method may be found in a review of various technical publications and comments

received on a prior notice of rule making. The following is quoted from the International Chamber of Shipping's statement which was attached to the IMCO Oct 1969, communication to the sixth session of the Committee of Experts on the Transport of Dangerous Goods:

The closed-cup method of testing should be used rather than the open-cup method in view of the former's much better precision.⁵

Proponents of the open-cup method point out that improvement in technique in recent years has resulted in increased precision and reproducibility of data. It is agreed that refinement of test methods has brought improvement. However, in spite of this improvement, the Board believes that the open-cup is still not equal to the closed-cup method for overall transportation safety purposes. For example, the report of the Subcommittee No. II of the Chicago Conference for Paint Technology⁶ summarizing findings done during 1968 with six different types of flashpoint testers and 27 solvent flash points ranging from 20° F. to 200° F. The report concluded that, "All closed-cup tests were considerably more reliable and easier to work with than the other cups."

Some comments received on Docket Notice No. 68-2 stated that a closed-cup test is not responsive to mixtures that contain a small amount of volatile nonflammable component. On the other hand, far too stringent mixtures containing very small (1 to 0.2 percent) amounts of highly volatile nonflammable compounds. During the test, the closed-cup can concentrate flammable vapors as readily as it can nonflammable vapors. These nonflammable vapors have a suppressant effect upon the flammability of the sample, thereby raising the flashpoint beyond the limit prescribed in the regulations for flammable liquids. In an open-cup, all of the vapors can escape, thus this suppressant effect. On the other hand, comments noted that a nonflammable knock compound containing less than 1 percent of dissolved hydrocarbon, by trapping of the hydrocarbon trace vapor space of the apparatus, had a closed-cup flashpoint of 58°-73° F., compared to an open-cup flashpoint of 180°-245° F.

The Board realizes that none of the currently available test methods applies to all mixtures. To cover the behavior of certain mixtures, the Board issues the necessary rulings. For example, the Board could classify such mixtures as nonflammable, depending on their flashpoint. There may be alternative methods to cover certain mixtures which do not fit themselves to the proposed testing method and the Board welcomes any suggestion in this regard. The decision as to the classification of exceptions could be based on other data or experience showing that a liquid is more or less hazardous than the flashpoint data indicate. The Board should not govern the general rule and the Board is concerned with the great majority of substances by the test method * * * .

The other principal matter in the preamble of 67 dealt with the Board's intent to not change "the present classification ranges or positions for flammable liquids," a position

¹ Docket No. HM-3; Notice No. 68-2 (33 F.R. 3882, Feb. 27, 1968).

² Kuchta, Joseph M. and Burgess, David, Report No. S. 4131, Apr. 29, 1970, Safety Research Center, U.S. Bureau of Mines. This document is available from the Clearing House for Federal Scientific and Technical Information, National Bureau of Standards, U.S. Department of Commerce, Springfield, Va. 22151, at a cost of \$3 per copy, or microfiche copy at 65 cents.

³ United Nations Economic and Social Council, E/CN.2/CONF.5/R.198.

⁴ Probst, K. G., Correlation of Methods for Measuring Flash Point of Solvents, Paint Technology, Vol. 40, No. 527, 1 (Dec. 1968).

n modified and which will be discussed in this preamble.

The comments made in response to 67 were rather diverse, ranging from full support of the proposal to being totally against it in all respects. Since that proposal is being modified by this notice, no attempt will be made to respond to all of the arguments presented, only to those that relate to changes made in response to comments.

Several commenters again pointed out that small quantities of volatile non-flammable materials in mixtures could mask the danger of "flammable" materials. The Board agrees and is proposing that tests be conducted on partially evaporated samples of mixtures. Conversely, another commenter pointed out that very small amounts of dissolved hydrocarbons (in his case less than 0.2 percent) in a mixture could cause an anomalously low closed cup flash point. The Board agrees that very small quantities of materials, meeting a proposed definition, should not have the effect of making 99 percent or more of a mixture subject to the requirements pertaining to that definition. Therefore, it is proposing exceptions to the two definitions. If tests on a material prove positive, the shipper will be afforded the opportunity of analyzing his material to determine if 99 percent or more of its components, when tested, do not meet either or both of the proposed definitions. Several commenters pointed out that the Tag closed-cup method is not appropriate for viscous materials and liquids which tend to form a surface film under test conditions, such as most paint products. The Board agrees and is proposing use of the Pensky-Martens Closed Tester (ASTM D93-71) for these materials as well as liquids that contain suspended solids.

The Board is proposing a modification of the proposal it made in 67 by raising the flashpoint for "flammable liquids" to (but not including) 100° F. closed cup. Also, it is proposing to change the upper limit for "combustible liquids" from 200° F. open cup to 200° F. closed cup with the same test criteria applicable to both definitions. The two principal reasons for these proposed modifications are: (1) To more properly reflect credible ambient temperatures in defining "flammable liquids," and (2) uniformity.

Ambient temperatures. A report entitled "A Survey of Environmental Conditions Incident to the Transportation of Materials" was recently prepared for the Department. In the "Summary of Conclusions" portion of the report, the following statement pertaining to temperature is presented:

4.7 *Temperature.* From the results of storage temperatures reported in the western

⁵ "A Survey of Environmental Conditions Incident to the Transportation of Materials, October 1971, PB-204-442" prepared by General American Research Division of GATX. This document is available from the Clearinghouse for Federal Scientific and Technical Information, National Bureau of Standards, U.S. Department of Commerce, Springfield, Va. 22151 at a cost of \$3 per copy or Microfiche copy at 95 cents.

desert, northern cold regions (Maine, Alaska, Washington), various other storage areas in the continental United States, Puerto Rico, and Hawaii, it is seen that temperature criteria for military equipment are too severe. A more accurate, but still conservative criterion is to apply extremes of local air temperatures. While this appears to neglect the results of solar thermal radiation, which for desert areas in summer is great, the data indicate that the thermal inertia and insulation of storage structures is sufficiently great such that attenuation of the swings in air temperature inside storage chambers results. The recorded extremes in air temperature in storage areas over the entire range of localities and structure types is -9° F. to 119° F., a much narrower range than the -65° F. to 160° F. expected values stated in MIL-STD-210A.

A limited amount of data for truck and rail transport also indicate that the cargo material undergoes swings in temperature which are greatly diminished from that of the forcing functions, the outdoor air temperature and solar thermal radiation.

The referenced 119° F. was arrived at from a report on the occurrence of higher temperatures in standing boxcars in which the highest measured temperature was 119° F. Similarly, in another study made under extreme temperature conditions in Death Valley, an overall maximum skin temperature and temperature within the cargo under test in a truck was 116° F. in response to a 130° F. maximum outside temperature on the day of the test. The Board concludes that it can reasonably assume that the temperature of cargo in transport vehicles can and often will reach or exceed 100° F. under conditions normally incident to transportation. This view is further supported by dry-bulb air temperatures for a 10-year period for 91 stations operated by the U.S. Weather Bureau. Temperature maximums for 10 representative locations were as follows:

Weather Bureau station	Period of record	Dry-Bulb Temperature Maximum
Chicago, Ill.	January 1949-December 1958.	104
El Paso, Tex.	January 1950-December 1959.	106
Los Angeles, Calif.	January 1949-December 1958.	107
Miami, Fla.	January 1948-February 1958.	98
Montgomery, Ala.	January 1949-December 1958.	105
New Orleans, La.	do.	100
Phoenix, Ariz.	do.	117
San Antonio, Tex.	do.	105
Seattle, Wash.	do.	97
Washington, D.C.	do.	102

The above data do not reflect the effects of radiation on transport vehicles and storage facilities used during the course of transportation.

The Board believes the regulations that apply to flammable liquids as they are defined at present should be made applicable to materials meeting its proposed new definition. However, the Board will consider providing additional packagings for these materials newly covered by the regulations if it adopts this proposal as an amendment.

Uniformity. One type of comment repeated often in 3, 42, and 67 was a need

for uniformity among the different regulatory agencies and other organizations having an effect on the manner in which shippers and carriers ship, store, and handle flammable and combustible liquids. Following publication of 67, this situation was further compounded by publication of new regulations by the Occupational Safety and Health Administration, U.S. Department of Labor, on May 29, 1971 (36 F.R. 10529) defining a flammable liquid as any liquid having a flashpoint below 140° F. (closed cup) and a combustible liquid as any liquid having a flashpoint at or above 140° F. and below 200° F. The Board agrees with the commenters who voiced their concern over the lack of uniformity and believes the area of greatest concern is the interface between transportation and nontransportation activities under the jurisdiction of the Department of Transportation and the Department of Labor, respectively. Another agency, the Food and Drug Administration, Department of Health, Education, and Welfare, has definitions for these materials defined by statute that are not consistent with the proposals herein. However, since the regulations of FDA are addressed to consumer-type packages that are primarily inside packages during transportation, the Board believes its most immediate concern should be the development of regulations compatible with those of the Department of Labor. The Assistant Secretary of Labor for Occupational Safety and Health agrees that there is a need for uniformity and his proposal for the modification of definitions set forth in 29 CFR 1910.106(a) are published at page 11901 of this issue of the FEDERAL REGISTER.

The Board will continue to seek adoption of the definitions proposed herein by all agencies in the United States, both State and Federal, and will also seek their adoption internationally.

Implementation. Some commenters requested that sufficient time be provided for re-evaluation of materials under the test method that was proposed in 67. The Board believes that approximately 1 year should be provided to permit testing and other necessary adjustments to accomplish compliance with the regulations under the new definitions. However, compliance should be authorized at an early date to permit adherence to the regulations of the Occupational Safety and Health Administration.

There are no proposals in this docket pertaining to placarding or marking of vehicles and portable tanks as proposed in 42. The Board will be making proposals in this area in the near future in a separate notice. Also, that portion of 42 pertaining to materials transported at temperatures higher than their flash points is not proposed in this docket as a mandatory requirement but in advisory language pertaining to materials that have flash points of 200° F. or higher.

In consideration of the foregoing, the Hazardous Materials Regulations Board proposes to amend 49 CFR Part 173 as follows:

A. In Part 173 Table of Contents, § 173.115 would be amended to read as follows:

Sec.
173.115 Flammable and Combustible liquids; definitions.

B. Section 173.115 would be amended to read as follows:

§ 173.115 Flammable and Combustible liquids; definitions.

(a) For the purposes of Parts 170-189 of this subchapter:

(1) "Flammable liquid" means any liquid having a flash point below 100° F. (37.8° C.).

(i) *Exception.* Any mixture having components with flashpoints of 100° F. (37.8° C.) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(2) "Combustible liquid" means any liquid having a flashpoint at or above 100° F. (37.8° C.), and below 200° F. (93.3° C.).

(i) *Exception.* Any mixture having components with flashpoints of 200° F. (93.3° C.) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(ii) *Qualification.* The limit of 200° F. is a limitation on the application of the regulations in Parts 170-189 of this subchapter and should not be construed as indicating that liquids with higher flashpoints are not flammable (when transported at elevated temperatures) or combustible. Markings such as "Non-flammable" or "Noncombustible" should not be used on a vehicle containing a material that has a flashpoint of 200° F. or higher.

(3) "Flashpoint" means the minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid and shall be determined as follows:

(i) For a liquid having a viscosity of less than 45 S.U.S. at 100° F. (37.8° C.), or that does not contain suspended solids, or have a tendency to form a surface film while under test, the procedure specified in the Standard Method of Test for Flashpoint by Tag Closed Tester (ASTM D56-70) shall be used.

(ii) For a liquid having a viscosity of 45 S.U.S. or more at 100° F. (37.8° C.), or that contains suspended solids, or has a tendency to form a surface film while under test, the procedures specified in the Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester (ASTM D93-71) shall be used.

(iii) For a liquid that is a mixture of compounds that have different volatility and flashpoints, its flashpoint shall be determined as specified in subdivision (i) or (ii) of this subparagraph on the material in the form it is to be shipped and on a partially evaporated sample obtained by placing a measured volume of the liquid in an open vessel at room temperature between 70°-80° F. (21.1° C.-26.7° C.) until 10 to 15 percent of the material by volume is evaporated. The lower value of the two tests shall be the flashpoint of the material.

(4) "S.U.S." means Saybolt Universal Seconds as determined by the Standard Method of Test for Saybolt Viscosity (ASTM D88-56) and may be determined by use of the S.U.S. conversion tables specified in ASTM Method D2161-66 following determination of viscosity in accordance with the procedures specified in the Standard Method of Test for Viscosity of Transparent and Opaque Liquids (ASTM D445-65).

(5) "Viscous" means a viscosity of 45 S.U.S. or more.

(6) "Pyroforic liquid" means any liquid that ignites spontaneously in dry or moist air at or below 130° F. (54.5° C.).

(b) If experience or other data indicate that the hazard of a material is greater or less than indicated by the results of the tests specified in paragraph (a) of this section, the Department may revise its classification or make the material subject to the requirements of Parts 170-189 of this subchapter.

(C) In § 173.119, the introductory texts of paragraphs (b) and (1) would be amended to read as follows:

§ 173.119 Flammable liquids not specifically provided for.

(b) *Flammable liquids with flashpoint above 20° F.* Flammable liquids with flashpoint above 20° F. and having vapor pressure (Reid° test) not over 16 pounds per square inch, absolute, at 100°

F. other than those for which requirements are prescribed in this section, must be packaged in packaging design and constructed of material which will not react dangerously with the material therein, as follows (see paragraph through (i) of this section for pressure liquids and paragraph (1) of this section for flammable liquids which are also oxidizing materials or toxic liquids):

(1) *Viscous flammable liquids with flashpoint above 20° F. and having vapor pressure which does not exceed 18 pounds per square inch, absolute, at 100° F.* Viscous flammable liquids with flashpoint above 20° F. and having vapor pressure which does not exceed 18 pounds per square inch, absolute, at 100° F. must be packaged as follows:

Interested persons are invited to submit their views on this proposal. Comments should identify the docket number and be submitted in duplicate to the Secretary, Hazardous Materials Regulations Board, Department of Transportation, 400 Sixth Street SW., Washington, DC 20590. Communications received on or before September 26, 1972, will be considered before final action is taken on the proposal. All comments received will be available for examination by interested persons at the Office of the Secretary, Hazardous Materials Regulations Board, both before and after the closing date for comments.

This proposal is made under the authority of sections 831-835 of Title 49, United States Code, section 9 of the Department of Transportation Act (49 U.S.C. 1657), and title VI and section 902(h) of the Federal Aviation Act of 1958 (49 U.S.C. 1421-1430 and 1471).

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* ASTM Test D323.